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26 March 1963

MEMORANDUM FOR : The Record

SUBJECT : A-12 Propulsion System Matching

1. In order for the A-12 aircraft to accelerate through the critical Mach range of 2.0 to 2.5, the propulsion system comprising air inlet, engine, and ejector must be matched in terms of a steady continuous airflow between each of these components. Reactions and interactions caused by airflow imbalance or mismatch between any two can result in intolerable deteriorations of thrust and drag and fuel economy.

2. Two air inlet systems critical to this airflow match are proper inlet spike and attendant shock position coupled with proper inlet bleed bypass door position for a given Mach number. These functions in effect size the inlet for varying Mach or ram conditions to ensure optimum airflow as required by the engine and are dependent upon proper operation and adjustment of the spike and bypass door controls, part of the airframe inlet control. This air must be delivered to the engine subsonically in a laminar (nonturbulent) condition without pressure or temperature distortion.

Confidential reports indicate that Lockheed engineers feel that air distortion exists as delivered by the inlet to the engine and that as a result approximately 15% less air is available than is required by the engine at the critical Mach range. If this is true, engine reaction of course would be first a reduction in burner pressure followed by reduced fuel flow, followed by reduced turbine temperature, followed by nozzle opening to maximum, and then a reduction in engine speed. The end result of course is a thrust decrease. Inlet distortion is a problem that has been experienced on other programs.

3. The engine bleed bypass transition from bleeds closed to bleeds open is currently set within the critical Mach 2.0 to 2.5 regime. This is mentioned as an engine item which may bear on the over-all propulsion problem because of the rather abrupt increase in airflow required by the engine of the inlet when this transition occurs. The transition point was established by joint Lockheed/Pratt & Whitney coordination.

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The other obvious area of engine suspicion would be the main fuel control because of its over-all authority of engine operating characteristics. Bench and ground engine tests, however, indicate satisfactory operation throughout the flight envelope including this critical Mach regime. This control is dependent upon inlet conditions in that its operation is dictated by inlet temperature and by burner pressure which relates to inlet pressure.

The increased engine nozzle area attendant with the 30% afterburner may also be a factor in the problem.

4. The airframe ejector, in addition to providing the divergent nozzle portion for accelerating engine exhaust gases (same as airflow) to high Mach numbers, also provides spillage for the inlet by means of secondary airflow through the nacelle. This secondary airflow draws from the inlet as pumped by the ejector. If the ejector fails to pump, this air is left in and can overload the inlet and either cause or contribute toward distortion and mismatch depending upon degree.

5. At this time, Pratt & Whitney performance engineers are meeting at Burbank with Lockheed engineers in an attempt to define this joint problem. Two engines are currently assigned to the problem and have replaced the performance improvement program currently being run in the altitude facility. Preliminary test data indicates that the installed conditions experienced in the aircraft during flight cannot be duplicated. With facility supplied airflow and exhaust, the engine system operates normally and as expected in this critical Mach regime. Further evaluation is underway.

Consideration is being given to additional ejector wind tunnel work and additional analog simulation of inlet/engine matching.

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